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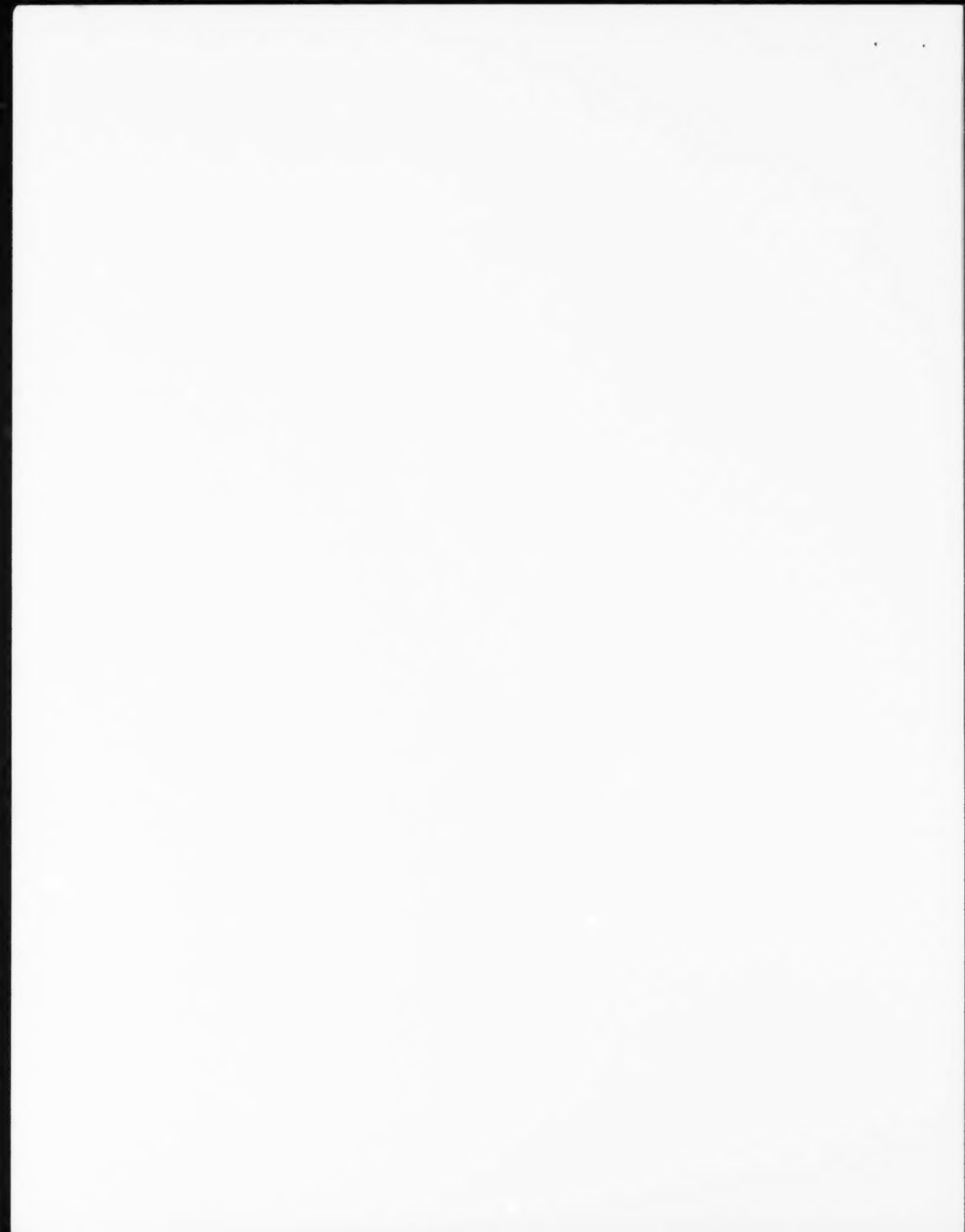
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**OFF-SEASON EVALUATION OF CHICKPEA
BREEDING LINES (PHASE II)**

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OFF-SEASON EVALUATION OF CHICKPEA BREEDING LINES (PHASE II)

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Summary

Chickpea is considered a high value pulse crop with potential for expansion in the Brown and Dark Brown soil zones of western Canada. Ascochyta blight is the major disease of chickpea in western Canada. To sustain and expand chickpea production in Saskatchewan, varieties with higher levels of ascochyta blight resistance are needed. Effective field selection for ascochyta blight resistance during the growing season in Saskatchewan is highly dependent on the environmental conditions. Selection for resistance is less effective during the dry years, while in years with above average rainfall, disease pressure would be too high for optimum selection efficiency. Indoor screening is relatively effective but is uneconomical for screening large numbers of breeding lines. The use of an off-season disease nursery will compensate for this problem. This research served as Phase 2 of the collaboration between the CDC and ICARDA for off-season evaluation of CDC chickpea breeding lines. During the three year (2007-2009) project period a total of 2,467 breeding lines from the CDC breeding program were sent to ICARDA for evaluation. All breeding lines were screened against the ascochyta blight disease under field epiphytotic conditions and were exposed to a mixture of ascochyta blight isolates ranged from moderately aggressive to highly aggressive. The lines were also grown in the fusarium wilt sick nursery and in cold tolerance screening nursery. This research has allowed us to effectively screen for resistance to ascochyta blight and fusarium wilt with tolerance to cold stress. As such, the project has identified potential breeding lines with improved ascochyta blight and fusarium wilt resistance and cold tolerance. This project and the collaboration between CDC and ICARDA on improving disease resistance in chickpea have enhanced the ability and allowed the modification of the CDC chickpea breeding strategy to develop and deliver future varieties with improved ascochyta blight resistance, fusarium wilt resistance and cold tolerance to the Saskatchewan industry. Additional benefit arising from this project is a strong long-term collaboration between CDC and ICARDA. The project has met all the objectives and goal within the given time period.

Introduction

In western Canada, chickpea is considered a high value pulse crop with potential for expansion in the Brown and Dark Brown soil zones. To sustain and expand chickpea production in Saskatchewan, varieties with higher levels of ascochyta blight resistance are needed. Effective field selection for ascochyta blight resistance during the growing season in Saskatchewan is highly dependent on the environmental conditions. Selection for resistance is less effective during the dry years. In contrast, in years with above average rainfall, disease pressure would be too high for optimum selection efficiency. Indoor screening is relatively effective but is uneconomical for screening large numbers of breeding lines. The use of an off-season disease nursery such as the ICARDA nursery will compensate for this problem.

The chickpea breeding program at the International Centre for Agricultural Research in the Dry Areas (ICARDA) in Aleppo, Syria has been in operation for decades with major focus on developing superior kabuli chickpea cultivars for Western and Central Asia and North Africa (WANA) regions. High yield with acceptable quality, resistance to ascochyta blight and fusarium wilt, tolerance to cold and drought are among the major breeding objectives. ICARDA operates the largest ascochyta blight and fusarium wilt disease nurseries in the world. These nurseries are inoculated multiple times annually. The ascochyta blight disease nursery is mist-irrigated to optimize disease development, which maintains the consistency of disease pressure and effectiveness of selection over years.

The first 5-year project funded by ADF entitled "Off-season evaluation of ascochyta blight reaction in chickpea" (Project # 2000-0219) was successfully completed in 2005. During the project time period, thousands of CDC chickpea breeding lines were evaluated at the ICARDA disease nurseries. The project has contributed to the development of a number of recently released chickpea varieties including CDC Frontier for Saskatchewan. Several other promising breeding lines have also been identified in that project.

The current activities served as Phase 2 of the project, which continued and further strengthened the collaboration between CDC and ICARDA. The primary objective of this project was to continue to utilize the off-season nurseries at ICARDA to evaluate the reaction to ascochyta blight, fusarium wilt and cold tolerance of CDC breeding lines in a systematic manner. The project has enhanced and intensified the long-term collaboration between CDC and ICARDA on improvement of agronomically and economically important traits of chickpea for Saskatchewan.

Background Information

Ascochyta blight: The disease is caused by the fungus *Ascochyta rabiei* (Pass.) Lab. Ascochyta blight is the major disease of chickpea in Canada and around the world. Previous reports showed that the fungus could survive in the diseased chickpea debris and in seeds from infected plants (Kaiser and Hannan, 1988; Trapero-Casas and Kaiser, 1992). Fungus could survive for two years in infected tissues. Pathogenic variability of *A. rabiei* has been demonstrated since the 1960s (Aujla, 1964; Kaiser, 1973; Grewal, 1984; Nene and Reddy, 1987; Kaiser, 1997). However, there has been no consensus as to whether the variability of *A. rabiei* is due to race or aggressiveness in a single race (Mmbaga, 1997). To date, *A. rabiei* isolates were classified into 3 groups (Pathotype-1, Pathotype-2, Pathotype-3) based on the reactions to a set of differentials on the host plant (ICARDA, 1998; Udupa et al., 1998; Jamil et al., 2000). Pathotype-3 is considered the most virulent isolate of *A. rabiei* (ICARDA, 1999). The application of foliar and seed

dressing fungicide, use of disease free seeds and field sanitation often only partially controlled ascochyta blight in chickpea especially when weather conditions become conducive for the disease development and spread. Under such situation, resistant sources against the blight and improved agricultural practices are the most effective strategy for its control. Development of high resistant to ascochyta blight is one of the major objectives of the chickpea breeding program at CDC.

Fusarium wilt: The disease is caused by the fungus *Fusarium oxysporum* f.sp. *ciceri*. Fusarium wilt is a serious and wide spread disease of chickpea in all countries with warm growing seasons. It has been reported to cause annual yield losses of as high as 50 percent in India and Pakistan. The disease is seed and soil borne. It can survive in soil even in the absence of the host for three years (Ayyub et al. 2003). The disease can occur at all stages of plant growth with more incidences in flowering and podding stage. When temperature is high (>24°C) particularly under drought, the disease could kill more than 80 percent of the plants in some production fields (Govil and Rana, 1994). Since the pathogen is soil borne and can survive in the soil for more than 3 years, continuous seed treatment can be useful in controlling soil born infection of the disease in varieties with moderate resistance. The ideal and most economical means of managing the chickpea wilt would be the use of resistant varieties. Resistance to wilt is race specific and is governed by major resistant genes. Eight races of the pathogen have been reported (Haware and Nene, 1982). To date *fusarium* wilt is not a problem for western Canadian environment due to cooler conditions in most of the production areas. However, it would still be beneficial to systematically evaluate the levels of resistance of the CDC chickpea breeding lines and varieties as self-protective approach should the disease incidence occurs especially in years with above average precipitation.

Cold tolerance: Chickpea is the least cold tolerant species among the cool-season food legumes. Historically, chickpea is grown as a winter crop in the subtropics and tropics and as a spring-sown crop in Mediterranean and temperate climates because the conventional cultivars tolerate only mild cold. Cold tolerance is one of the most important pre-requisites for winter or fall-sown chickpea. Even for spring-sown crop like in western Canada, cold tolerance at early seedling stage is important. It will allow the crop to be seeded early in the season. Continuous efforts are needed for the improvement of cold tolerance at the CDC chickpea breeding program. Three important conditions are needed in the development of cold-tolerant chickpea lines. These factors are characterization of the stress, identification of genetic variation and availability simple screening methods. Singh and Saxena (1999) have developed a field technique for screening chickpea for cold tolerance which involves: (1) sowing the germplasm and breeding materials in early October with supplemental irrigation to allow the crop to achieve a late vegetative growth stage before the onset of severe winter conditions in late December; (2) planting of a susceptible check after every 2-10 test lines; and (3) evaluating the materials on a 1-9 scale after the susceptible check is killed. Three key elements in characterization of an abiotic stress are the intensity and duration of stress, rate of stress development and phenological timing of stress (ICARDA, 2006).

Materials and Methodology

Each year in October during the three year project period (2007-2009), approximately 800 F4 families (50 seeds per family) from the CDC chickpea breeding program were sent to ICARDA at Aleppo, Syria for evaluation. The samples were initially grown as short row plots under quarantine conditions from January to June to meet the Syrian government

regulations. Harvested seeds of F5 families were then evaluated in ICARDA ascochyta and fusarium wilt nurseries in the following season (November to June). A subset of the seeds were also seeded early (first week of October) to allow screening for cold tolerance.

Evaluation for Ascochyta blight resistance. For ascochyta blight evaluation, each entry was sown in a single 3 meter long row and 30cm apart. A highly susceptible line (ILC263) was planted as spreader at every ten rows. Crop management was done following the general agronomic practices for the region. Disease observations were recorded on the scale of 0 – 9; 0 = no disease and 9 = plants completely blighted. The ascochyta blight pathogen population structure in Syria consists of moderately aggressive (pathotype-1 and 2) and highly aggressive (pathotype-3) isolates. The CDC germplasm were exposed to a mixture of these isolates. Disease ratings were done by ICARDA researcher and were utilized by the CDC breeding program to identify lines with improved levels of ascochyta blight and fusarium wilt resistances. The promising lines were re-tested in subsequent seasons to confirm their resistances to ascochyta blight and fusarium wilt.

Evaluation for fusarium wilt resistance. The lines were planted in a wilt sick nursery at ICARDA during the following crop year: 2008, 2009 and 2010. Each entry was sown in a single 3 meter long row and spaced at 30cm between rows. A highly susceptible line (ILC482) was planted as spreader at every ten entries to allow uniform infestation of the disease in the field. The crop was raised with general agronomic practices. Disease observations were recorded as early wilt which was done few months after sowing and late wilt during pod filling period in the last week of April. Wilt disease incidence was determined according to the following scheme i.e. 0 percent incidence (highly resistant), 1-20 percent incidence (resistant), 21-40 percent incidence (moderately resistant), 41-80 percent incidence (susceptible) and 81-100 percent disease incidence (highly susceptible).

Evaluation for cold tolerance. The screening for cold tolerance was done during three consecutive growing seasons (2008-2010) at the ICARDA research station at Tel Hadya, near Aleppo, Syria. The site is located at 36°01' N, 36°56' E, 284m above the sea level with the mean annual rainfall of 330 mm. The CDC breeding lines were screened for cold tolerance using the field screening technique developed at ICARDA. The lines were planted in early October. Each plot was a single row with 3 m length and 30 cm apart. Cold susceptible check (ILC533) was seeded at every ten rows in the same nursery. With respect to the long term weather pattern in the cropping season, cold stress was normally severe in January and February when the crop at vegetative stage. The breeding lines were evaluated after the death of the susceptible check due to cold conditions.

Results and Discussion

During the three year project period (2007-2009) a total of 2,467 breeding lines from the CDC breeding program were sent to ICARDA for evaluation. These lines were selected from various tests in Saskatchewan based on yield potential, earliness and relative seed quality. After passing the quarantine process, the lines were evaluated in ascochyta blight, fusarium wilt and cold tolerance nurseries in subsequent growing season. Remnant seeds of 640 lines that were sent from CDC in 2005 and 2006 (Phase 1 of the project) were also seeded in 2008 for disease evaluation. All breeding lines were screened against the ascochyta blight disease under field epiphytotic conditions and were exposed to a mixture of ascochyta blight isolates ranged from moderately aggressive (pathotype-1 and 2) to highly aggressive (pathotype-3; Figure 1 and 2). Ascochyta blight reaction was rated on a 0

– 9 scale (0 = no symptomp and 9 = plants killed), while reaction to fusarium wilt was rated as percentage of plants killed by the fungus. Reactions of current commercial varieties for ascochyta blight, fusarium wilt and cold stress are presented in Table 1. Two of the current varieties (CDC Anna and Myles) are highly resistant to fusarium wilt; whereas all the newer varieties (CDC Cabri, CDC Vanguard, CDC Corinne, CDC Frontier and CDC Luna) have improved resistance to ascochyta blight. CDC Luna in particular also has relatively good tolerance to cold stress.



Figure1. Variations in reaction of CDC chickpea breeding lines to ascochyta blight at the ascochyta disease nursery during the 2009-2010 growing season at ICARDA station near Tel Hadya, Syria. The plots were irrigated several times a day using a misting irrigation system. Insert: a tag showing the first plot of the CDC breeding lines.

Table 1. Reactions of current chickpea commercial varieties for ascochyta blight, fusarium wilt and cold stress.

Variety	Type	Fusarium wilt	Ascochyta blight	Cold tolerance
Myles	Desi	5.0	6.0	8.0
CDC Anna	Desi	5.0	5.5	8.0
CDC Cabri	Desi	75.0	5.0	5.3
CDC Vanguard	Desi	100.0	5.5	8.0
CDC Corinne	Desi	100.0	4.0	8.0

CDC Cory	Desi	100.0	5.0	8.0
Sanford	Kabuli	95.0	8.5	7.0
CDC Xena	Kabuli	100.0	9.0	8.0
Amit	Kabuli	100.0	5.5	7.0
CDC Frontier	Kabuli	100.0	4.5	6.7
CDC Luna	Kabuli	100.0	5.0	5.3
491-5	Kabuli	50.0	5.0	na
493-24	Kabuli	100.0	3.5	na
603-3	Desi	5.0	4.0	na
612-14	Desi	90.0	5.0	na
551-1	Desi	50.0	3.0	na



Figure2. Variations in reaction of CDC chickpea breeding lines to ascochyta blight at the ascochyta disease nursery during the 2009-2010 growing season at ICARDA station near Tel Hadya, Syria. The plots were irrigated several times a day using a misting irrigation system. Plot showing the susceptible check (ILC 263) is indicated.

Results of evaluation of 1,440 breeding lines in 2008, 840 lines in 2009 and 827 lines in 2010 for reaction to ascochyta blight are summarized in Figure 3. The detail scores of each line are available upon request. The results revealed a considerable variation on the

disease reaction among chickpea genotypes. Mainly three qualitative groups of disease response i.e. good, fair and poor (susceptible) were noticed in these genotypes. It was observed that only very few of the genotypes was highly resistant (score lower than 3.0). This also reflected the conducive environmental conditions for disease during screening. These genotypes found with high resistance would be retested to confirm their resistance. As expected, the number of resistant and moderately resistant genotypes (score 6.0 or lower) were higher due to the extensive use of resistant materials from local germplasm and international sources in the breeding program. It appeared that for screening under field conditions at least two weeks of continuous 90% RH are necessary for uniform spread of the disease, which sometimes becomes difficult under dry weather conditions.

The screening work has resulted in the identification of some specific moderately resistant lines to ascochyta blight that also have high yield potential under Saskatchewan conditions. These lines included 491-5 (released in 2010 as CDC Orion), 493-24 (will be released in 2011 or 2012), among others (Table 1) were selected for high yield under western Canadian conditions and will be released for western Canadian growers in the coming year; while many others (Table 2) are being used in crossing block at the CDC breeding program. Disease etiology work indicated that the 1-9 scale is suitable to differentiate between resistant and highly susceptible cultivars but not so for the intermediate reactions. Current results confirmed that the genetics of resistance to ascochyta blight is quantitative rather than qualitative in nature.

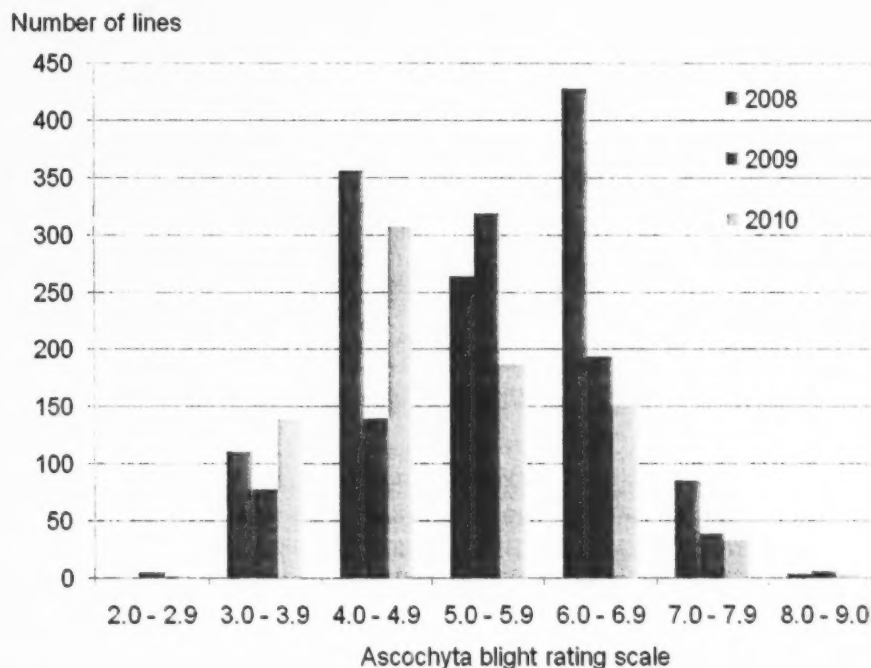


Figure 3. Frequency distribution of 3,107 CDC chickpea breeding lines for their reaction to ascochyta blight in 2008 (1,440 lines), 2009 (840 lines) and in 2010 (827 lines) growing seasons at ICARDA Research Station, Tel Hadya, Syria. The susceptible check (ILC263) had a score 8.8 or higher in all plots in each year.

Figure 4 shows the frequency distribution of the CDC chickpea breeding lines for their reaction to fusarium wilt in the three year period. The detail scores of each line are available upon request. Pearson correlation coefficient between the reaction to ascochyta blight and fusarium wilt for lines that were evaluated 2008 is highly significant ($r = 0.26$; $P = 0.00$) suggesting the existence of lines that are resistance to both diseases; whereas the correlations for the samples that were evaluated in 2009 and 2010 are not significant. A number of lines highly resistant to both ascochyta blight and fusarium wilt were identified from the three year evaluations.

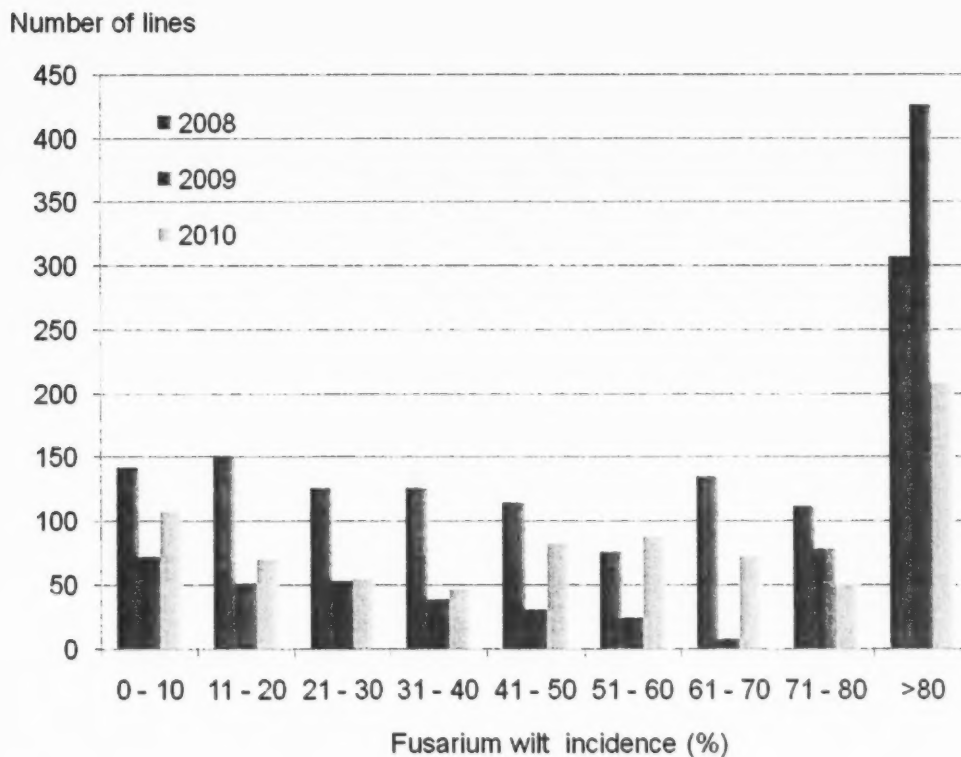


Figure 4. Frequency distribution of 3,107 CDC chickpea breeding lines for the fusarium wilt disease incidence in 2008 (1,440 lines), 2009 (840 lines) and in 2010 (827 lines) growing seasons at ICARDA Research Station, Tel Hadya, Syria. The susceptible check (ILC482) had a disease incidence of 95% or higher in all plots in each year.

Table 2. List of selected lines with improved ascochyta blight and fusarium wilt resistances at seedling and podding growth stages.

Name	Ascochyta Blight	Fusarium wilt (seedling)	Fusarium Wilt (Podding)
1072-2	5.0	0.0	15.0
1072-3	5.0	5.0	20.0
425-12	5.0	0.0	10.0
548aS-20	4.0	0.0	5.0
551-49	5.0	0.0	0.0
611-8	5.0	5.0	5.0
837-29	5.0	0.0	10.0
841-3	5.0	0.0	0.0
841-4	4.0	0.0	0.0
841-5	4.0	0.0	5.0
880-12	4.0	0.0	15.0
888-14	5.0	0.0	0.0
888-15	5.0	0.0	15.0
888-26	5.0	0.0	5.0
888-5	5.0	0.0	10.0
888-8	4.0	0.0	10.0
921-10	5.0	5.0	5.0
FLIP 03-112C	5.0	0.0	0.0
FLIP 03-69C	4.0	0.0	20.0
FLIP 03-77C	5.0	0.0	0.0
FLIP 03-88C	4.0	0.0	20.0
FLIP02-47C	5.0	0.0	20.0
FLIP03-114C	4.0	0.0	20.0
FLIP03-115C	4.0	0.0	0.0
FLIP03-118C	3.0	5.0	10.0
FLIP03-123C	5.0	0.0	20.0
FLIP03-141C	4.0	0.0	0.0
FLIP03-146C	3.0	0.0	0.0
FLIP03-29C	5.0	0.0	10.0
FLIP03-34C	5.0	5.0	10.0
FLIP03-37C	4.0	0.0	20.0
FLIP03-42C	5.0	0.0	15.0
FLIP03-77C	4.0	5.0	20.0
FLIP03-96C	4.0	0.0	15.0
FLIP93-230C	5.0	0.0	15.0
GPE-179	5.0	5.0	20.0
x2001th 43-3	5.0	0.0	15.0

The severity of cold stress experienced by the lines varied with their date of germination and the extent of cold temperature in each year. The susceptible check (ILC 533) killed due to frost only happened in 2010 when the night temperature dropped to -6.6°C for 4 days in mid January (Figure 5). The frequency distribution of the lines for their reaction to cold stress is presented in Figure 6. There were no days during the growing seasons in 2007-2008 and in 2008-2009 with the minimum temperature below -4°C (Table 3). In addition, the period of below zero temperature only happened in a very short period during 2007-08 and 2008-09 growing seasons. No cold tolerance data was collected in 2007-08 and in 2008-09 seasons as no frost damaged was observed in the susceptible check (ILC533).

Table 3. Records of lowest minimum temperature (°C) at Tel Hadya station for screening for cold tolerance during the growing seasons of 2007-2008, 2008-2009 and 2009-2010

Month	2007	2008	2009	2010
January	-	-3.6	-3.9	-6.6
February	-	-2.2	0.9	4.2
March	-	7.0	1.9	2.0
November	0.2	5.2	2.4	-
December	-3.0	2.8	4.1	-



Figure 5. Variations in reaction of CDC chickpea breeding lines at cold tolerance nursery during the 2009-2010 growing season at ICARDA station near Tel Hadya, Syria. Plot of susceptible check (ILC 533) and other susceptible lines are shown.

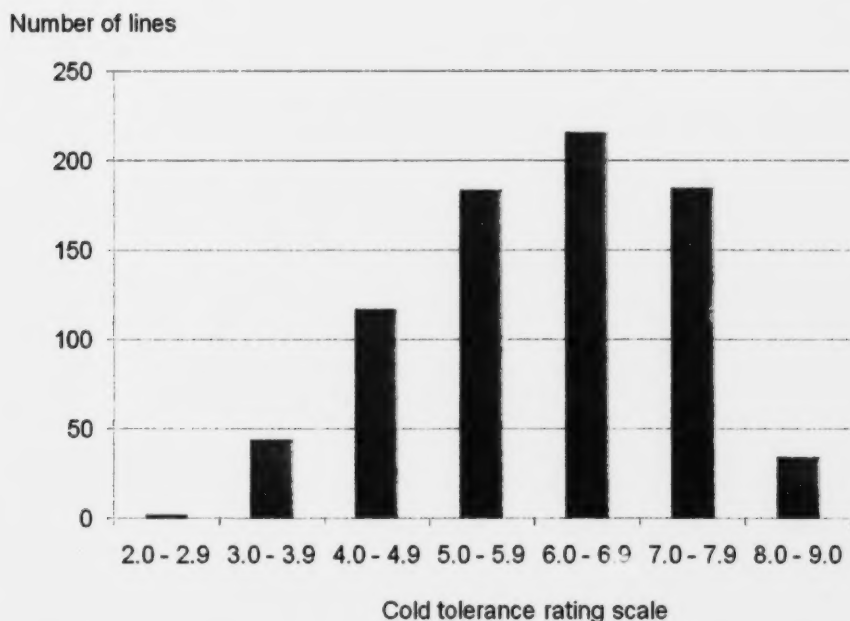


Figure 6. Frequency distribution of 827 CDC chickpea breeding lines for their reaction to cold stress during the 2009-2010 growing seasons at ICARDA Research Station, Tel Hadya, Syria. The susceptible check (ILC533) was killed by the cold conditions.

Preliminary observations indicated that most of genotypes with high cold tolerance score had more secondary branch number. It appeared that the cold tolerant chickpea varieties could sustain the cold stress without significant damaged and be able to continue to grow and develop more secondary branches. The highly cold tolerant entries such as 820-32 (Figure 7) also matured very early. This line had FLIP90-127C in its background. This background line was derived from hybrids of crosses done at ICARDA more than a decade ago between cultivated varieties (*C. arietinum* L.) with *C. reticulatum* (accession ILWC 182), a wild relation of cultigens. These results indicated that useful genes for cold tolerance could be transferred from alien chromosomes of wild relatives to cultigen. Towards this end, the physiological and biochemical bases for cold tolerance are still unclear and must be investigated further.



Figure 7. Performance of CDC breeding lines including the tolerant line (CDC 820-32) at the cold tolerance screening nursery during the 2009-2010 growing season at ICARDA station near Tel Hadya, Syria.

The development of chickpeas with improved resistance to ascochyta blight and with a greater degree of adaptability to cold conditions (Table 3) especially during the early vegetative stage may allow early seeding in the prairie regions to mid April as soon as the seeders could run through the field.

Table 3. List of selected lines with improved ascochyta blight resistance and cold tolerance based on screening at the ICARDA Research Station, Tel Hadya, Syria.

Name	Ascochyta blight	Cold tolerance
1016-1	3.0	4.0
1023-8	3.0	4.3
1023-9	3.0	4.3
1079-1	4.0	4.0
1083-2	4.5	4.3
1088-1	4.0	4.3
1128-12	3.0	4.0
1174-1	4.0	4.0
1174-2	4.0	4.0

1174-3	4.0	3.7
1174-4	4.0	4.0
1174-5	3.5	4.0
1234-8	4.5	4.0
1239-2	3.0	4.0
1241-2	4.0	4.0
1256-2	4.0	4.3
1256-5	3.0	4.3
820-32	4.5	3.0
CA05-75-58	3.0	4.3

Implication on breeding strategy

Because of the devastating potential of ascochyta blight and the anticipation of the potential of fusarium wilt diseases, the chickpea breeding program at CDC has set multiple resistances to be part of the breeding objectives. The approach includes the incorporation of resistance for these two diseases and cold tolerance in the same background. Targeted crosses are made to allow screening of multiple resistances plus the cold tolerance in the progeny. Single crosses, three way and double crosses were made using resistant parents identified in the current project. The F1 generation is grown under disease free conditions. The F1 is harvested as single plants which are planted as F2 progenies in the ascochyta blight nursery. Improved resistant F2 plants are harvested as single plants and advanced to F3 progenies. The F3 families are screened again against ascochyta blight. Resistant F3 families are then selected. Subset of the seeds is sent to ICARDA and is planted as F4 and F5 progenies for ascochyta blight, fusarium wilt and cold tolerance screening. Second screening is done in the F6 progenies for ascochyta blight, fusarium wilt and cold tolerance. The remaining (unsent seeds) of the F4 and F5 progenies are bulked and evaluated for yields in Saskatchewan. The system takes five years before reaching the multilocation trial phase. The system allows for at least two screening cycles for both diseases and for screening against cold conditions.

The project has met all the objectives and goal as listed in the original proposal within the project time period. The deliverables from this project include:

- 1) This research has allowed us to effectively screen for resistance to ascochyta blight and fusarium wilt with tolerance to cold stress. As such, the project has identified potential breeding lines with improved ascochyta blight and fusarium wilt resistance and cold tolerance.
- 2) This project and the collaboration between CDC and ICARDA on improving disease resistance in chickpea have enhanced the ability and allowed the modification of the CDC chickpea breeding strategy to develop and deliver future varieties with improved ascochyta blight resistance, fusarium wilt resistance and cold tolerance to the Saskatchewan industry.
- 3) Additional benefit arising from this project is a strong long-term collaboration between CDC and ICARDA.

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Papers/Presentations:

Oral presentation was given at ICARDA staff meeting on May 23, 2010.

(d) Information of benefit to producers, processors, or governments:

Chickpea production contributes significantly to the Saskatchewan economy, however, its sustainability in production and its expansion have been limited by several factors including ascochyta blight as a major disease resulting in reduced yield and quality. The current project of using the off-season nursery has enhanced the capability for selection

for improved resistance to ascochyta blight and has enabled selection for resistance to fusarium wilt and cold tolerance. Improvement of these traits in future chickpea varieties will enable the crop to be grown over a larger area in Saskatchewan with reduced production risk and will contribute to sustainable disease management systems, thereby potentially increasing the use of chickpea in crop rotations. Overall the long term output of the research will enhance the competitiveness, profitability and sustainability of the pulse industry in Western Canada.

Potential varieties developed through this research project will be released to the Saskatchewan Pulse Growers via an existing agreement with the CDC. The Saskatchewan Pulse Growers fund the production of Breeder Seed for release through their Variety Release Committee to Select seed growers in Saskatchewan and Alberta.

(e) Personnel:

One-month salary of one pulse crops field lab technician was paid by this project. The technician was assigned for duties including seed preparation of the selected lines, labeling, packaging and sending to ICARDA.

(f) Equipment purchased:

None

(g) Project Developed Materials:

The plant materials evaluated and identified in this project are parts CDC breeding program to develop improved varieties for western Canadian growers.

(h) Project Photos:

Several photos of the nurseries at the ICARDA station were taken. They will be available upon request.

(i) Acknowledgement:

The Provincial Government of Saskatchewan and the Saskatchewan Agricultural Development Fund are acknowledged in all presentations where this research project is mentioned.

(j) Expense Statement:

Will be provided.

(k) ICAR Data Entry

Will be entered.

